Gel-electrospinning Process for High Performance Polymer Nanofibers
Technology #18241

Application

This technology can be applied to make polymer nano-fibers with mechanical properties comparable to conventional high-performance fibers. These fibers might be used to develop all-polymer composites for use in body armor.

Problem Addressed

Conventional high-performance polymer fibers are produced using a process known as gel spinning. These fibers have excellent mechanical properties such as modulus and strength. However, gel spinning is unable to produce fibers with sub-micron diameters due to limitations in the ability of mechanical systems to exert the larger hydraulic forces required and to interface with sub-micron scale fibers.

On the other hand, electrospinning has been used to produce sub-micron fibers for a range of applications ranging from filter to battery materials. However, conventional electrospun fibers have inferior mechanical properties that prevent their use in applications that demand high mechanical resilience, such as textiles.

This invention describes a hybrid process called gel electrospinning, capable of producing sub-micron fibers with mechanical properties comparable to conventional high-performance fibers.

Technology

In the novel process described by the Inventors, a polymer filament is formed by electrospinning at elevated temperature. During this process, the filament undergoes electrostatically driven drawing and whipping processes that stretch it and reduce its diameter to sub-micron levels. Unlike conventional electrospinning, the drawing and whipping processes take place at elevated temperatures. The process temperatures are chosen so that the solution filament undergoes a gel transition as it is stretched, which increases the degree of molecular orientation in the resulting fiber and improves its mechanical properties. For example, the Inventors have successfully produced UHMWPE fibers with a diameter of 0.3 µm and a Young’s modulus of approximately 120 GPa -- comparable to that of conventional Spectra fibers.

Advantages

- Superior mechanical properties compared to conventional electrospun sub-micron fibers
- Higher specific surface area and toughness compared to conventional high performance fibers
- Orders of magnitude higher productivity compared to production of high-performance sub-micron fibers by tip drawing
Categories For This Invention:

- Materials
- Fabrics, Fibers & Textiles
- Polymers (Materials)

Intellectual Property:

Gel-electrospinning process for preparing high-performance polymer nanofibers
US Patent Pending

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Gel-electrospinning process for preparing high-performance polymer nanofibers
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